Air Pollution Technology Fact Sheet

1. ***Name of Technology:*** Mechanically-Aided Separators

This type of technology is a part of the group of air pollution controls collectively referred to as "precleaners," because they are oftentimes used to reduce the inlet loading of particulate matter (PM) to downstream collection devices by removing larger, abrasive particles. Mechanically-aided separators are also referred to as mechanical separators, mechanical centrifugal separators, centrifugal collectors, dry dynamic separators, dry rotoclones, and dynamic precipitators.

2. ***Type of Technology:***

Removal of PM by centrifugal and inertial forces, induced by mechanically accelerating particulate-laden gas.

3. ***Applicable Pollutants:***

Mechanically-aided separators are used to control PM, and primarily PM greater than 8 to 10 micrometers (μm) in aerodynamic diameter (Wark, 1981; Avallone, 1996).

4. ***Achievable Emission Limits/Reductions:***

The collection efficiency associated with a mechanically-aided separator is comparable with a high-pressure-drop cyclone. Mechanically-aided separators are capable of collection efficiencies approaching 30 percent for PM less than or equal to 10 μm in aerodynamic diameter (PM_{10}) (Perry, 1984; EPA, 1998).

5. ***Applicable Source Type:*** Point

6. ***Typical Industrial Applications:***

Mechanically-aided separators have been used in the food, pharmaceutical, and wood-working industries. Due to their compact size, they are often used in applications where space is restricted or many individual units are desired. Mechanically-aided separators have generally been supplanted by cyclones for most applications (Wark, 1981; Corbitt, 1990; Perry, 1984; Josephs, 1999).

7. ***Emission Stream Characteristics:***

a. ***Air Flow:*** Typical gas flow rates for a mechanically-aided separator range from 0.75 to 10 standard cubic meters per second (sm^3/sec) (1,590 to 21,200 standard cubic feet per minute (scfm)) (Wark, 1981; Josephs, 1999).

b. ***Temperature:*** Inlet gas temperatures are limited to less than approximately 370°C (700°F) (Wark, 1981).

c. ***Pollutant Loading:*** Waste gas pollutant loadings typically range from 10 to 250 grams per standard cubic meter (g/sm^3) (4 to 110 grains per standard cubic foot (gr/scf)) (Wark, 1981).

d. ***Other Considerations:***

8. Emission Stream Pretreatment Requirements:

Mechanically-aided separators may be preceded by another separation device to remove larger particles which may damage or clog the mechanically-aided separator.

9. Cost Information:

The following are cost ranges (expressed in third quarter 1995 dollars) for a single conventional mechanically-aided separator under typical operating conditions, developed using a modified EPA cost-estimating spreadsheet (EPA, 1996), and referenced to the volumetric flow rate of the waste stream treated. For purposes of calculating the example cost effectiveness, flow rates are assumed to be between 0.75 and 10 sm^3/sec (1,590 and 21,200 scfm), the particulate loading is assumed to be PM at an inlet loading of between approximately 10 and 250 g/sm^3 (4 to 110 gr/scf) and the control efficiency is assumed to be 80 percent. The costs do not include costs for disposal or transport of collected material. Capital costs can be higher than in the ranges shown for applications which require expensive materials. As a rule, smaller units controlling a low concentration waste stream will be more expensive (per unit volumetric flow rate) than a large unit cleaning a high pollutant load flow.

a. ***Capital Cost:*** \$8,000 to \$36,000 per sm^3/sec (\$4 to \$17 per scfm)

b. ***O & M Cost:*** \$12,000 to \$156,000 per sm^3/sec (\$6 to \$74 per scfm), annually

c. ***Annualized Cost:*** \$13,000 to \$161,000 per sm^3/sec (\$7 to \$76 per scfm), annually

d. ***Cost Effectiveness:*** \$2.60 to \$900 per metric ton (\$2.40 to \$820 per short ton), annualized cost per ton per year of pollutant controlled

10. Theory of Operation:

Mechanically-aided separators involve the use of a rotary vane (e.g., radial blade fan) to mechanically impart a centrifugal force on the particles in the gas stream causing them to separate from the gas stream. The particles are collected in a dust hopper for removal and disposal. The most common design is a modified radial blade fan where the particulate laden gas stream enters the device perpendicular to the blade rotation, and momentum forces the particles to cross the gas stream and collect in the side of the device casing. The blades and casing are especially shaped to direct the separated dust into an annular slot leading to the collection hopper while the cleaned gas continues to the device outlet. By operating at low speeds (400 to 800 rpm), the effects of abrasion and material buildup are minimized (EPA, 1982; Corbitt, 1990; Perry, 1984).

11. Advantages/Pros:

Advantages of mechanically-aided separators include (Wark, 1981; Corbitt, 1990; and EPA, 1998):

1. Compact design and small space requirements;
2. Higher collection efficiencies of smaller particles than other precleaner designs;
3. Dry collection and disposal; and
4. Small space requirements.

12. Disadvantages/Cons:

Disadvantages of mechanically-aided separators include (Wark, 1981; Corbitt, 1990; and EPA, 1998):

1. Higher power requirements and operating costs than other precleaner designs;
2. Higher maintenance requirements than other precleaner designs;
3. Unable to handle sticky or tacky materials; and
4. More subject to abrasion than other precleaner designs.

13. Other Considerations:

Mechanically-aided separators may no longer be manufactured. Cyclones, which have lower maintenance and operating costs, are generally used for small-space requirement applications where mechanically-aided separators would have been used in the past (Josephs, 1999).

14. References:

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Corbitt, 1990. "Standard Handbook of Environmental Engineering," edited by Robert Corbitt, McGraw-Hill, New York, NY, 1990.

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EPA, 1996. U.S. EPA, Office of Air Quality Planning and Standards, "OAQPS Control Cost Manual," Fifth Edition, EPA 453/B-96-001, Research Triangle Park, NC February, 1996.

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Josephs, 1999. D. Josephs, Equipment Product Manager, AAF International, (502) 637-0313, personal communication with Eric Albright, October 28, 1999.

Perry, 1984. "Perry's Chemical Engineers' Handbook," edited by Robert Perry and Don Green, 6th Edition, McGraw-Hill, New York, NY, 1984.

Wark, 1981. Kenneth Wark and Cecil Warner, "Air Pollution: Its Origin and Control," Harper Collins, New York, NY, 1981.